Three Level Access Model

Amir Hossein Tabbakhpour Langeroodi[1]*.

1. M.Sc., Transportation Engineering and Planning, Department of Transportation, Faculty of Civil Engineering, Iran University of Science and Technology, Tehran, Iran, a_tabbakhpour@civileng.iust.ac.ir.

Abstract

The level of access is an important and practical indicator in measuring the usability of a facility, which can be used to evaluate the compatibility of what was intended in the design with what is used by users. In various studies and evaluations, depending on the opinion of the researcher and expert, levels are usually defined for access in the scope of coverage, which depends on diagnosis and experience. In this article, the numerical effectiveness of the behavior of applicants to use the services of each facility at any distance from those limits and the methods of calculating the effective range and the Three level Access Model (TLAM) are presented. The central coverage in this model is defined in three access levels around the center, each of which includes 25%, 25%, and 50% of the covered area, respectively.

Key words: Accessibility, Access Level, Effective Range, Land Use Planning.

1. Introduction

Access is the level of usability of services or the level of availability, which is defined by different dimensions such as location access, time access, usage access, etc. Access is an important computational variable that is used in land use planning and the placement of service-facilities, and with its help, the quality of the facility's usability is measured by each user at any point. For example, in spatial access, the smaller the distance required from the user's base position to reach the target user, the more accessible that user will be to that facility, but the qualitative expression of access cannot be affected in studies and planning in this way. Using the concept of access in calculations requires the definition of indicators and calculation variables that provide a specific numerical limit for each level of quality, hence the level of usability or the level of service to each user is measured by a variable called "Access Level".

The access level index can be defined and used in all dimensions of access, and in this study, according to the focus on physical access to each facility, access is studied in spatial and temporal dimensions. The equivalent amount of time access can also be converted to location access with the help of user condition information such as speed, movement time, age, gender, etc. Both can be examined in the dimension of location access such as location difference, distance, or length. In land use planning and especially in the location of uses, the issue of access is carefully studied depending on the importance of the project and studies, but despite the importance and wide application of the access level in these studies, the values of the access level are still the opinion of experts and experienced people is assumed to be based on taste, and a specific value for it is not provided as a standard.

The performance difference between what is designed in studies and what is implemented in reality has become a fundamental challenge for engineers and planners. In many infrastructure plans and projects or studies related to public and service feasibility, this difference is more noticeable, so that sometimes in reality less than 20% of the target community that is used in the studies as the target community to provide services in It was considered that they will be able to be used in reality. In infrastructure plans, the occurrence of such errors on the one hand leads to the supply of services without use, and on the other hand, it forces the community to use the service to be void. Its compensation is usually not easily possible or involves significant costs. To improve scientific knowledge in this field, this article, by analyzing and numerically calculating the limits of the access level, has been calculated using mathematical relations, from which it is possible to 1) in the phase of study and planning with design based on the standard limits of a more accurate plan and presented

close to the reality, and 2) in the performance evaluation phase using a standard measure of accessibility, target community coverage, and compatibility between the design and what has been implemented.

2. Methodology

The research method of this article is based on fundamental concepts with the help of mathematical relationships to investigate the exact numerical value of the limits of the access level for more compatibility of design with reality, which is in four steps: 1) understanding and physical definition of access concepts, 2) mathematical and geometric modeling of variables calculation, 3) coverage network design patterns, user range, and access in the covered area, and 4) calculation output and result table of the amount of different variables in the access level and the target community have been investigated.

In this study, accessibility around a point is defined as the geometric centrality for the user, and this point is known as the origin of computing coordinates. After determining the computing center, the basic concepts and related variables can be shown physically on a model. (Figure 1) In this model: the origin of the coordinates is the user whose access is checked, (this point can be the geometric center of the user or the location of the user's entrance door), the radius of nominal or design coverage is the largest distance According to the definition of the nominal coverage radius or the design, the nominal coverage area or the design is a circle with the center of the user location and the radius of the nominal coverage radius.

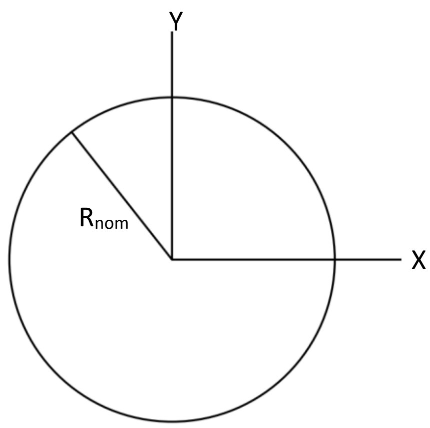

Figure 1: Basic model

In real conditions, the area to be covered by a user can be an urban area or a region that does not have a regular geometric shape. On the other hand, in maps, usually the surface of the land shown in the map is graded by a grid and from the cell Squares are formed, and their set does not coincide with the circular geometric surface. Also, in the design of a group of users in a linear or multi-line form, some areas are outside the coverage area, but they have access to the desired user to meet their needs, hence the actual coverage of the area is a square surface around the center. is defined Based on this, the model can be completed as (Figure 2).

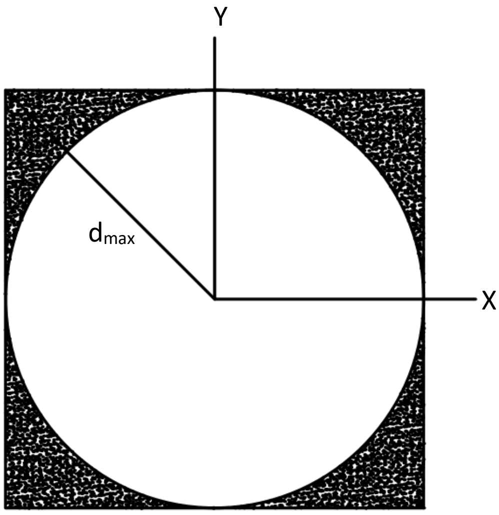

Figure 2: Basic model with additional zone

The maximum distance (d_{max}) that a user may travel at each access level is calculated as follows.

$$(1)\quad d_{max} = \sqrt{2}.R_{nom}$$

Where in: R_{nom} is the nominal access radius, and R_{max} is the maximum distance of the covered area from the computing center.

And the area of the additional coverage area (A_{add}) outside the coverage radius (assuming the uniformity of the population density) is:

$$(2)\quad A_{add} = A_{max} - A_{nom}$$

Where in: A_{max} is total coverage area, and A_{nom} is nominal area

By (equation 1), the value of the additional coverage range can be rewritten as below.

$$A_{add} = d_{max}^2 - \pi.R_{nom}^2 = (\sqrt{2}.R_{nom})^2 - \pi.R_{nom}^2 = 4.R_{nom}^2 - \pi R_{nom}^2 = (4-\pi)R_{nom}^2$$

The additional population ratio (r_{add})is also calculated as.

$$(3)\ r_{add} = \frac{A_{dd}}{A_{nom}}$$

And its final value is:

$$r_{add} = \frac{(4-\pi)R_{nom}^2}{\pi.R_{nom}^2} = \frac{(4-\pi)}{\pi} \cong 0.273$$

Now, the second level of access can be defined to the desired point with the help of the maximum length, while in the second level of access, this value is again introduced as the nominal coverage radius, and the same things can be repeated for it. Repeating it twice to reach the separated access in three levels results in a model like this (Figure 3).

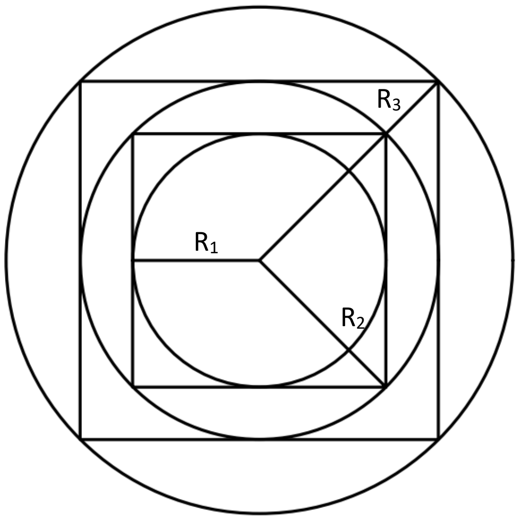

Figure 3: Three Level Access

whose ratio is:

$$R_3 = \sqrt{2}.R_2 = 2.R_1$$

According to the mentioned concepts, the central coverage of this point can be divided into four areas with three levels of access, and the final coverage model can be completed (Figure 4), where Z_1, Z_2, Z_3, and Z_4 represent the range of access level 1 coverage area, access level 2 coverage area, access level 3 coverage area, and additional zone coverage area.

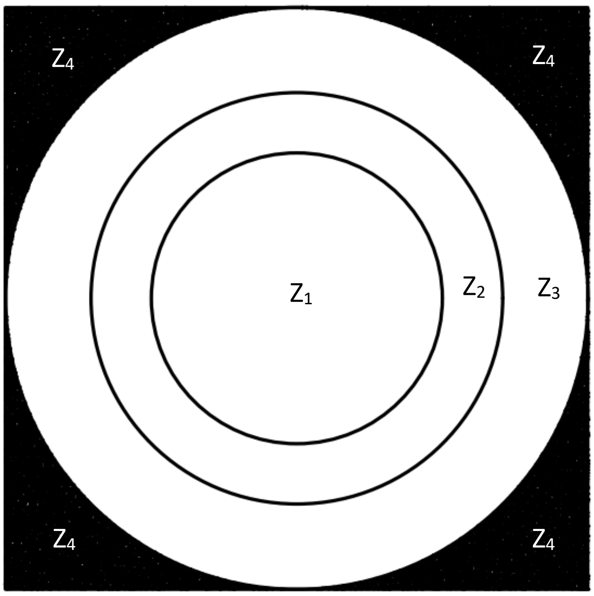

Figure 4: Three Level Access Model (TLAM)

In this structure, the concept of access level means exactly how much the user has to pay in each access level to reach the destination. (The meaning of the cost is the amount equivalent to the different dimensions of access in terms of spatial access) with the help of (Relation 4), the quality of access from each point to the user location can be valued and calculated according to the distance required to reach it. The boundary conditions of this equation are known based on the maximum utility at the zero distance and the minimum utility at the maximum distance from the center because it shows respectively the points where the user is located exactly at the user's location or at the location where the user's maximum choice distance is to the title of the final goal of the choice is known and the user chooses an alternative place at a greater distance from it.

$$(4) \quad V_i = 100 - \frac{50\sqrt{2}.x_i}{R}$$

Where in: V_i is the accessibility value of the location of the point to the user center, x_i is the distance of the point from the user center, and R is the coverage radius.

In the group location of such users as transportation terminals, banks, schools, stores, etc., all the centers provide exactly the same service, if the arrangement of the centers in the network is done correctly (conditions that do not overlap between the centers and not a cover gap), the radius of the design cover is chosen as half the distance between the two centers.

(Conditions where the model circles of the coverage areas are tangent to each other) and in such conditions, the radius and coverage area of the design is selected in this way.

But the implemented plan will behave differently in reality because in this model the free and direct access routes are oriented towards the center, but in real conditions, the distance required to reach the desired place is not a direct distance and should be based on the routes in the transportation network is routed and the length of the route should be considered as the access length. In this situation, the actual coverage range will be much lower than the design coverage range, and this difference is calculated by the (equation 5) as the "Coverage ratio index". The coverage ratio index shows the compatibility and centrality of the land use with the existing transportation network, which measures the performance of each access level.

Where in: A_{real} is the area covered by each access level in real conditions, and A_{des} is the area covered by each access level in the design.

$$(5)\ CI = \frac{A_{real}}{A_{des}}$$

In (Table 1), the numerical data of the variables related to the level of access in the central three-level access have been calculated and presented.

Table 1: Three Level Access Model data

Distance from center (x_i)	Level Length (share from Effective Radius) (L_i)	Zone (Z_i)	Area (A_i)	Area Ratio (A_i/A)	Access Value (V_i)
0	0	-	0	0	100
$\frac{1}{2}R$	0.5	1	$\frac{\pi}{4}R^2$	0.25	64.64
$\frac{\sqrt{2}}{2}R$	0.2	2	$\frac{\pi}{4}R^2$	0.25	50
R	0.3	3	$\frac{\pi}{2}R^2$	0.5	29.29
$\sqrt{2}R$	0.4	4	$(4-\pi)R^2$	0.273	0

3.Discussion and conclusion

According to the three-level access model presented in (Figure 1) and the numerical values of access and coverage variables in each layer presented in (Table 1); The centralized coverage area of a user can be divided into three levels of access and four coverage areas, each of which

is approximately 0.5, 0.7, and 1 from the coverage radius, the coverage share of each of the total coverage area is the order is 0.25, 0.25, 0.5, and the access value of each layer is approximately at least 65, 50, and 30. Also, in this model, the excess demand of the user who is outside the coverage area of the access radius, but uses the desired user service, has been calculated. And indicators are provided to calculate the quality of access in each layer and the total coverage ratio, which can be used to evaluate access.